

THE LEAF ANATOMY AND VEGETATIVE CHARACTERS OF THE INDIGENOUS GRASSES OF NEW SOUTH WALES. I.

ANDROPOGONEAE, ZOYSIEAE, TRISTEGINEAE.

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(Forty-three Text-figures.)

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Introduction.

Increasing interest in present-day pasture problems, and the number of workers experimenting with pastures, have made it a matter of some importance that there should be a means of identifying species of grasses at times when the flowering shoots are not present. Most of the other constituent species of pastures may usually be recognized fairly readily at all stages of development by their habit and macroscopic leaf-characters. However, in many cases, and wherever the turf is closely grazed, the general vegetative features of a number of grass species growing together may be so similar as to make their diagnosis on macroscopic characters very uncertain or almost impossible.

A few workers have therefore directed their attention to the anatomy of the grass leaf, as shown in transverse section, as an aid in the determination of species when their vegetative parts only are available.

The general morphology of the grass leaf has been discussed by Duval-Jouve (1870), Schwendener (1889, 1890), and Pée-Laby (1898). MacAlpine (1890) and Ward (1901) used characters of the leaves as seen in transverse section as aids in identification. In 1904, Lewton-Brain described the anatomy of the leaves of British grasses, with a key for their determination.

Bews (1918) figured a number of transverse sections of leaves of South African grasses, and discussed the relationship between such features of the leaf of a species as its degree of lignification, and its palatability to stock and use as a pasture grass. In a recent publication, Burr and Turner (1933) described and figured transverse sections of the leaves and young shoots of the British economic grasses, and gave two keys for their identification based respectively on the vegetative, and on the anatomical characters. In Australia, Breakwell (1914, 1915) has described and figured the transverse sections of some of the native grasses.

The writer proposes to publish a series of papers describing the vegetative features and the anatomical characters of the leaves of the indigenous grasses of New South Wales, and to construct an artificial key which will aid in their identification.

While this should be of material assistance to ecologists and pasture workers, it should be remembered that such identification is only provisional until complete flowering material is available. In cases where there is a known assemblage of grasses in an area, it can be used without hesitation to separate the plants when

in their vegetative state alone, but where the assemblage is quite unknown, it must be used more cautiously.

Many characters seen in transverse sections of leaves are found to be quite constant and can be used with confidence in identification, but other characters may vary with the habitat of the plant, the size of the leaf, and the position in the leaf at which the section is made.

In this study it has been found, as by previous workers, that closely allied species may have an almost identical anatomical structure, particularly when they exist in similar habitats, and that even widely separated species may strongly resemble each other in transverse section. To attempt to separate such species on minute differences would almost certainly lead to confusion, so the writer has considered it better to group the species with similar anatomy, than to attempt to distinguish them completely on characters which may prove unreliable and variable.

In Australia the great variation in the habitat factors, edaphic, climatic, and seasonal, makes it a matter of very considerable difficulty to arrive at a conclusion as to what is the typical form of a species, and to include in its description all the possible variations met with. For instance, such species as *Themeda avenacea*, *Cymbopogon bombycinus*, and *Cymbopogon exaltatus* may have flat leaves of about 5-7 mm. width, and, under different conditions, filiform leaves which consist essentially of an enlarged midrib region without the expanded lateral portion of the blade. Such a reduction in the width of the leaf usually involves a reduction in the number of vascular bundles; therefore little reliance can be placed on the number of large and small bundles present. Throughout the descriptions which follow, dimensions of the leaf and numbers of the bundles are given merely to indicate the order of magnitude, and to give some standard to the less exact descriptive terms, but they cannot be taken as showing the absolute limits of variation.

Similarly the size and degree of development of the midrib vary tremendously in different leaves of the same species and at different points along the leaf, so that its appearance in transverse section can only be of importance when taken in conjunction with its macroscopic appearance in a number of leaves.

Material and Methods.

The writer is indebted to Mr. E. Cheel, Curator of the National Herbarium, Sydney, for permission to inspect the collection of grasses at the National Herbarium, to Mr. Cheel and Mr. D. Cross for assistance in the determination of the systematic position of a number of species, and to Mr. S. Blake for material sent from Queensland.

The greater part of the material used for anatomical investigation has been collected by the writer from plants growing under field conditions in various parts of New South Wales. In a number of instances, sections for purposes of confirmation have also been made from herbarium material from different localities. In the case of a very few species where fresh or fixed material was not available, use was made of dried herbarium material boiled out before sectioning. Such sections were seldom completely satisfactory, as it is difficult to obtain good recovery in tissues showing such differential thickening as do those of a grass leaf, but usually the general type of anatomy could be made out. Wherever possible, a fairly wide range of material from a number of different localities was examined.

Fresh leaves were usually fixed in 70-95% alcohol. Hand-sections of all material have been cut in pith, microtome sections proving unsatisfactory. It is essential to maintain an extremely keen edge on the razor, and stropping or grinding is necessary after every few sections. Very thin sections are desirable, but it is even more important that the sections should be absolutely transverse. For reference purposes, sections have been double stained and mounted in Canada balsam, or mounted direct into glycerine jelly coloured with various stains. For identification purposes only this is unnecessary; fresh leaves may be cut, the sections placed in alcohol for a few moments to expel air, and mounted in water or glycerine. The various anatomical features can be readily recognized without staining.

Well-developed leaves from the lower vegetative part of the plant should always be taken, never those from the culm. In the case of annual plants on which the leaves occur only on the culms, a leaf from as near the base as possible should be selected. As the anatomy of the leaf varies in some details from the base to the apex, sections should always be made at a point one-third of the length of the leaf blade from its base.

Systematic.

During the last 20-30 years, considerable changes in the nomenclature of Australian grasses have occurred, owing to recent critical systematic work. As these changes are for the most part scattered through the literature and difficult for anyone but the experienced systematist to obtain without considerable labour, it has been thought desirable wherever possible to include after the name at present adopted, those synonyms which have appeared in Australian literature. It is hoped that this summary will reduce the inevitable confusion due to the use of different names by the various Australian authorities from time to time. No attempt has been made to include synonyms used in other parts of the world, or to undertake a critical revision of the nomenclature. It is to be expected that further changes will take place during the next few years. The species are arranged according to the tribes of Hackel (1896).

Vegetative Characters and Growth Forms.

As the vegetative organs and growth forms of the Gramineae are well known (see Hackel, 1896; Bews, 1929; Hutchinson, 1934), reference will only be made to those features of particular importance in the present study. With the exception of the Bambuseae, the grasses are all annual or perennial herbs, usually branching at the base. In the annuals all the shoots are flowering shoots (culms). In perennials, sterile shoots (innovations) are also formed, which are responsible for the formation of the 'flag' or basal tuft of leaves. The shoots may be erect or prostrate. Where the latter predominate, and have comparatively long internodes, the plants develop a creeping or straggling habit. These horizontal portions may be above or below the surface of the ground, forming stolons or rhizomes respectively. More often the prostrate shoots have extremely short internodes, and bear numerous erect or ascending shoots, giving the plant the characteristic tufted habit of most pasture species.

The culm may be circular in outline in cross-section, or sometimes angular or flattened. The nodes are glabrous or ciliate.

The leaf sheaths are typically split along one side (open) and rolled around the culm, or may ultimately slip from it, but in some species the sheath is closed

and tubular (entire) for at least part of its length. The sheath may be rounded at the back, or definitely flattened.

At the upper end of the sheath, at its junction with the blade, is the ligule, which may be membranous or ciliate. In the former case it may be acute, or truncate, long or short, sometimes almost absent. Lateral auricles may also occur.

The character of the ligule is often regarded as an important diagnostic feature. It is best developed by the culm leaves, however, and is not so useful a character when the leaves of innovations only are available.

The blade is usually linear, but in some species may be narrow lanceolate or ovate. In some species the leaves are filiform, due either to a permanent inrolling of the margins, as in some forms of *Poa caespitosa*, or to a reduction of the blade to an enlarged midrib region, as in *Cymbopogon exaltatus* (Text-fig. 7). Linear and filiform leaves may occur in the same species.

The leaves typically have parallel venation. The presence or absence of a well-defined midrib may be of importance. Where this causes a prominent ridge on the lower surface, the leaf is said to be keeled. In some species, e.g. *Neurachne Mitchelliana* and *Zoysia Brownii* (Text-figs. 34 and 40), the midrib cannot be distinguished, but in other cases it varies, being large and conspicuous near the base of the leaf, but scarcely distinguishable towards the apex. The number of lateral veins visible macroscopically may vary with the width of the leaf, but the approximate number and their wide or close spacing may be of importance in some of the broader-leaved forms.

Different species vary in the behaviour of the leaves on drying. In a few the leaves remain fairly flat, e.g. *Oplismenus* spp., *Brachiaria* spp. In many the margins become inrolled, and in others the two halves of the leaf fold together at the midrib. In some types, e.g. *Cymbopogon refractus*, *Dichanthium sericeum* and allied species, the leaves fold inwards a little at the midrib, but the margins become rather reflexed. A few species have permanently folded or rolled leaves, e.g. some forms of *Poa caespitosa* and *Danthonia pauciflora*.

Some species may produce numerous hairs on the leaves and sheaths, but this is often an unreliable character, although fairly constant in a few types. The presence of microscopic pointed hairs may give the leaves and sheaths a rough or scabrous feel, according to their abundance, but, although this may at times be a useful feature, most species are rather variable in this respect.

Leaf Anatomy.

Reference has already been made to the work of previous investigators, and workers are advised to consult Lewton-Brain (1904) for a more detailed description of the grass leaf-anatomy.

In an examination of the grass leaf in transverse section the following features should be noted:

The upper surface of the leaf may be flat, undulating, or ribbed. If ribbed, the ridges may be high or low, acutely pointed, rounded or flattened at the apex. Low ribs may also occur on the lower surface in a few species (e.g. Text-figs. 4, 5, 34). The width and thickness of the leaf should also be noted.

The epidermis consists of two types of cells: (a) small, often thick-walled cells which make up the lower epidermis and part of the upper epidermis, and (b) larger, usually thinner-walled 'motor cells' or 'bulliform cells' (e.g. Text-figs. 3, 6, 39). These motor cells are arranged in longitudinal bands throughout the length of the leaf. In transverse section, they are usually seen in groups

situated at the base of the grooves in the case of leaves which have a ribbed upper surface; where the leaves have a flat surface they occur between the larger bundles, sometimes between every bundle. In some leaves they occur only above or at each side of the midrib (e.g. Text-figs. 9, 12, 18). In shape the groups may be rather elongated, composed of cells of a rather similar size, becoming gradually larger towards the centre of the group, or short, often with a very conspicuously larger central cell, giving the group a triangular outline. The individual motor cells may be rounded and only distinguishable from the other epidermal cells by their size (Text-figs. 21, 28), but more often they are narrow at their outer side, and rather broad at the base where they are in contact with the chlorophyll tissue (Text-figs. 37, 39). The typical motor cells grade into the ordinary epidermal cells on either side of the group.

These motor cells allow the leaf to roll or fold on drying, according to their position, as they are large and comparatively readily compressed. Whether these cells actually cause the rolling movement by collapse due to water loss, or whether their size and plasticity merely permit them to be compressed and so allow rolling to take place, has been the subject of some controversy. It has been postulated by some writers that rolling is of considerable biological importance, in that it occurs at times of water shortage, and results in the leaf becoming tubular. Thus the stomates on the upper surface, often on the sides of the grooves, are protected from excessive transpiration. This teleological viewpoint is not supported by the fact that in many Australian grasses, including drought-resistant forms, which exhibit the rolling movement, the stomates are more numerous on the exposed lower surface, where they would rather tend to be held open by the rolling.

The ordinary epidermal cells vary in size and in the thickness of the wall in different species. They are often square or rectangular in section, or the outer wall may be more or less arched or papillate. The papillate appearance may be due to the very strong arching of the whole outer wall, or more often to the presence of a number of separate papillae arranged in a longitudinal row, as seen in surface view. Where these are in a single row, and as wide as the epidermal cell, the outer wall appears to be very strongly arched in transverse section (L, in Text-figs. 3 and 16). Where the papillae are narrower than the epidermal cell, they appear in transverse section as small distinct papillae on the outer wall. If there is more than one row on each epidermal cell, then the outer wall shows bifurcate or multiple papillae (L, in Text-fig. 32).

In a few species with a strongly papillate epidermis, the cell beside a stomate in the same longitudinal row has a large papilla nearest the stomate. In transverse section, therefore, the cell which is placed immediately below a stomate appears more swollen than the neighbouring epidermal cells. This is seen in *Dichanthium sericeum* and *Bothriochloa decipiens*.

A few species (e.g. *Tragus racemosus* and *Neurachne Mitchelliana*) bear long tubercle-based hairs, but these are more easily observed macroscopically than in section. Long silky hairs are seldom developed by Australian species, but short stiff hairs are quite common. Where these are very short, they form stiff emergences or asperities (A, Text-fig. 3). These reduced hairs are the cause of the rough or scabrous feel of the leaf. They may be reflexed so that the leaf is scabrous when the hand is rubbed along it in one direction, but not in the other.

The cells of the chlorophyll tissue (chlorenchyma) may be arranged in two distinct ways: (a) when the vascular bundles are fairly widely spaced, the

chlorenchyma may be more or less irregularly arranged between them (Text-fig. 35); (b) when the vascular bundles are relatively close together, the chlorenchyma forms a fairly regular row around them, with just a few cells between. In this second type, the chlorenchyma cells usually appear narrow in transverse section, with their long axes at right angles to the bundles, giving the section a distinctive appearance (e.g. Text-figs. 3, 37). A variation of this type is found in which the chlorenchyma cells are rather shorter and rounder, approaching the arrangement of the irregular type. Where additional cells occur between the rows around the bundles, they usually contain distinctly less chlorophyll.

In general, however, the two main types of arrangement are very sharply defined, with comparatively few intermediate forms, and this feature constitutes a very valuable diagnostic character. Both types are well represented amongst Australian grasses.

Intercellular spaces occur between the cells of the chlorenchyma, but in the accompanying diagrams these have been neglected, since it has been considered that the general structure of the leaf as it appears in transverse section can better be emphasized if they are omitted. They may, however, be very conspicuous, especially in hygrophilous species. In others, e.g. *Vertiveria elongata* (Text-fig. 12), large air-cavities are present.

The conducting tissue of the vascular bundles is surrounded by a sheath consisting of one or two layers, with which the metaxylem vessels are in contact. Where two layers are present, the inner one consists of small cells with sclerized walls, the inner and lateral walls often more strongly thickened than the outer, resembling the typical monocotyledon endodermis. Often this layer cannot be distinguished in the small bundles, although present in the large bundles of the same leaf. The outer layer consists usually of larger, thinner-walled cells. Around the smaller bundles these are as conspicuous as around the larger, or more so. In *Aristida*, however, the inner sheath consists of larger cells than the outer and is conspicuous around all the bundles.

In other species, including most of the Andropogoneae, the bundle sheath consists of a single layer of rather large cells, which become fairly strongly sclerized around the large bundles, but are only slightly thickened around the smaller (e.g. Text-figs. 3, 30). These cells are sometimes almost clear (*Neurachne Mitchelliana*). In other cases they contain a certain amount of chlorophyll, though usually not as much as the chlorenchyma cells, and occasionally they appear to have unusually dense contents (*Tragus racemosus*). These cells form a layer which may completely encircle the bundle or may be interrupted by the intrusion of groups of fibres above and below the bundle. According to the arrangement of the sheath cells, the bundles, especially the smaller, may be circular (Text-fig. 1), oval or triangular (Text-fig. 40) in outline. In the lower magnification diagrams, these cells are included in the bundles.

The largest vascular bundles of the leaf have the typical monocotyledonous structure, with two large metaxylem vessels, a protoxylem vessel, or the space in which it occurred, and a number of smaller lignified elements forming the xylem, and a small group of phloem consisting of sieve tubes and companion cells. The smaller bundles have considerably reduced tissues.

Pée-Laby divided the vascular bundles into five orders. The first order comprises those with distinct protoxylem and metaxylem vessels, and group of phloem; the second order is similar, except that the protoxylem is absent; the third order has neither metaxylem nor protoxylem, but a number of lignified

elements; the fourth order resembles the third, but has fewer lignified cells; and the fifth has no lignified tissue. In practice, it has been found that bundles of the fifth order are seldom seen, and those of the fourth cannot usually be distinguished from the third order bundles. Second order bundles are also very erratic in occurrence, and often appear to take the place of a first order bundle in the leaf. In some species, however, it may be convenient to distinguish between the first and second orders. In the following descriptions, only the first, second, and third order bundles are referred to.

The tissue of the bundles in the various species is so uniform that it is seldom useful as a means of identification, but the number of bundles of the different orders and their relation to the ribbing of the leaf and position of the motor cells is of importance.

The stereome or mechanical tissue consists of groups of fibres. These are usually placed above and below the bundles, and when connected with the bundles are said to form girders. At other times, hypodermal groups occur which are not connected with the bundles, or which may be placed between the bundles. In a few species a continuous hypodermal band may be formed, usually on the lower side. A group of fibres also occupies the margins of the leaf. Although it is subject to a certain degree of variation in any species, the distribution and quantity of stereome is of considerable importance in diagnoses.

The general distribution of each species in New South Wales is given after the description of the vegetative characters, and the localities from which material has been examined anatomically are stated after the description of the anatomical characters in each case.

Description of Species.

ANDROPOGONEAE.

ANDROPOGON.

Most of the species of *Andropogon* of Benthams's "*Flora Australiensis*" are now referred to the genera *Amphilophis*, *Bothriochloa*, *Cymbopogon*, *Dichanthium*, *Schizachyrium*. The species at present included under *Amphilophis* may, on further study, be found to be referred more correctly to *Bothriochloa*. Other writers have also included the genera *Capillipedium*, *Chrysopogon*, *Heteropogon*, *Sorghum*, and *Vertiveria* in the genus *Andropogon*.

DICHANTHIUM.

DICHANTHIUM SERICEUM A. Camus. (Syn. *Andropogon sericeus* R.Br.)

Erect, tufted perennial, usually not very large, 15-75 cm. high, but producing a considerable amount of flag, typically glaucous, but a green form also common; base of the stem very slightly aromatic; nodes prominently ciliate; leaves linear, narrow, 5-25 cm. \times 2-4 mm., glabrous, smooth to rough but hardly scabrous, folding inwards slightly and the margins recurving on drying; midrib present, at least in the lower part, though scarcely prominent; ligule membranous truncate, jagged, or ciliate. *Distribution*: All over the State, especially in the northern districts west of the Divide. Pasture species.

Anatomical characters: (Text-fig. 1. Cf. also Text-fig. 3.) Leaf rather thin; both surfaces flat; upper epidermis consisting of elongated groups of about 3-8 motor cells, interrupted over every fourth, sometimes every second bundle by smaller, thick-walled, rather papillate epidermal cells; motor cells of each group of similar size, the central few rather larger, occupying about half the leaf thick-

ness. A few colourless cells may occur beneath the motor cells, especially near the midrib region. Cells of the lower epidermis distinctly, usually very strongly papillate, the cells under a stomate usually more prominently swollen than the other epidermal cells; stomates mostly on the lower surface, few on the upper surface; chlorenchyma regular; bundle sheath single, forming a circular layer. About 7 bundles of the first order occur, with 3-8 bundles of the third order between each; midrib usually moderately conspicuous in section, with a group of colourless cells above the midvein and associated bundles; stereome very weakly developed as a small group of fibres above and below bundles of the first order, forming girders with them, and as an extremely small group below, and sometimes above every second and especially every fourth bundle of the third order, but not usually connected to them. *Localities*: Warialda, Dungog, Narrabri, Gobarralong.

DICHANTHIUM ANNULATUM Stapf. (Syn. *Andropogon annulatus* Forsk.)

Tufted erect perennial, not large, 20-60 cm. high, producing a little flag; nodes ciliate or glabrous; sheaths almost glabrous, smooth, very slightly flattened upwards; leaves linear, 7-15 cm. \times 2-5 mm., glabrous or with a few hairs, smooth or slightly rough, folding inwards slightly and the margins recurving on drying; midrib present but hardly prominent; ligule of long cilia. *Distribution*: Northern coast and tablelands. Pasture species.

Anatomical characters: (Resembles *D. sericeus*. See Text-fig. 1.) Leaf fairly thin; both surfaces flat or almost so; upper epidermis consisting of elongated groups of about 4-10 motor cells, interrupted over about every second, occasionally only over every fourth bundle; motor cells of similar size, the central ones rather larger, occupying nearly half the leaf thickness. Occasionally a few colourless cells occur below the motor cell groups; lower epidermal cells with moderately thick, very conspicuously papillate outer walls; stomates more numerous on the lower surface, few on the upper surface; chlorenchyma regular; bundle sheath single forming a circular layer. About 7-9 bundles of the first or second order occur, with about 3-7 bundles of the third order between each; midrib present with a group of colourless cells above the midvein and associated bundles; stereome very weakly developed as a small group of fibres above and below the bundles of the first order with which short girders are formed, and as extremely small groups of about 1-5 fibres below every bundle, and above about every second, of the third order, but not forming girders. *Localities*: Glen Innes, Botanic Gardens, Rockhampton (Q.).

BOTHRIOLCHLOA.

BOTHRIOLCHLOA DECIPIENS C. E. Hubbard.

(Syn. *Amphilophis decipiens* Domin, *Andropogon decipiens* Domin, *Andropogon pertusus* Benth., *Fl. Aust.* non Willd., *Andropogon pertusus* var. *decipiens* Hack.)

Rather slender, tufted, erect or ascending perennial, 30-90 cm. high, producing a comparatively small amount of flag; culms often pinkish; nodes glabrous; sheaths glabrous, smooth, rather flattened, lightly striate; leaves narrow, linear, 2-15 cm. \times 2-5 mm., glabrous, smooth to rough, folding inwards slightly and the margins recurving on drying; midrib present, especially towards the base; ligule membranaceous, truncate, 1-2 mm. long. *Distribution*: Throughout the State. Pasture species.

Anatomical characters: (Text-figs. 2 and 3.) Resembles *Dichanthium sericeum*. Leaf rather thin; both surfaces flat; upper epidermis consisting of

elongated groups of about 4-8 large motor cells, interrupted by smaller epidermal cells over about every second bundle; all motor cells of the group of rather similar size, the central ones of each group only slightly larger, and occupying about one-third to one-half the thickness of the leaf; cells of the lower epidermis fairly thin-walled, prominently papillate, moderately large, unequal in size, the cell seen immediately below a stomate usually distinctly more swollen than the others; stomates present on both surfaces, occurring between the groups of motor cells on the upper surface, more numerous on the lower surface; chlorenchyma regular; bundle sheath single, forming a circular layer. About 7-9 bundles of the first order occur, with 3-7 bundles of the third order between each; midrib usually moderately conspicuous in section with a group of colourless cells above the midvein and associated bundles; stereome very weakly developed as a rather small group of fibres above and below bundles of the first order, forming small girders, and sometimes also as a very small group above and below every second or fourth bundle of the third order but not connected to them to form girders. *Localities*: Sydney, Homebush, Cobbitty.

BOTHRIOLCHLOA ERIANTHOIDES C. E. Hubbard.

(Syn. *Andropogon erianthoides* F. Muell.)

Tall, erect, tufted perennial, 60-120 cm. high, often glaucous; nodes glabrous; stems and base of sheaths shining; leaves linear, 10-60 cm. \times 2-8 mm., flat, smooth or with rather scabrous margins, folding slightly and the margins recurving on drying; midrib whitish and prominent in the lower part of the leaf; ligule membranous, jagged. *Distribution*: Western parts of the State, chiefly in the north. Pasture species.

Anatomical characters: (Resembles *Dichanthium sericeum* and *Bothriochloa decipiens* in structure, cf. Text-figs. 1-3, but the leaf is much wider.) Leaf very thin; both surfaces very flat; upper epidermis composed of elongated groups of 4-12 motor cells interrupted by smaller epidermal cells over bundles of the first order, and over every second, third, or fourth bundle of the third order; motor cells of similar size, the central ones slightly larger, occupying one-third to one-half the thickness of the leaf. A few colourless cells may occur below the motor cells, especially near the midrib; lower epidermal cells with moderately thick, arched to slightly papillate outer walls; chlorenchyma regular; bundle sheath single, forming a circular layer. About 11-13 bundles of the first and second order occur, with 3-7 bundles of the third order between each; midrib fairly conspicuous in section, with a mass of colourless cells above the midvein and associated bundles; stereome very weakly developed as a rather broad but thin mass above and below bundles of the first order forming short girders with them, and as a very small group below, and occasionally above some bundles of the third order, but not connected with them to form girders. *Localities*: Warialda, Moree. Dried specimens only examined.

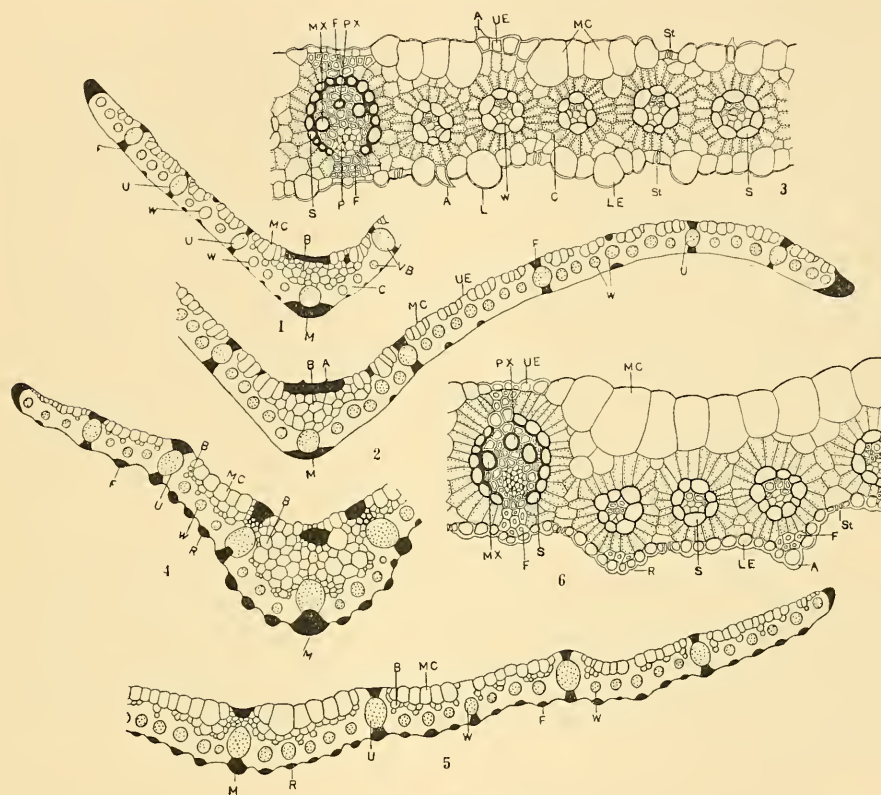
AMPHILOPHIS.

AMPHILOPHIS AFFINIS A. Camus. (Syn. *Andropogon affinis* R.Br.)

Tufted, erect or ascending, rather slender glabrous perennial, 25-60 cm. high, not forming a very great quantity of flag; nodes glabrous or pubescent; sheaths and leaves glabrous, smooth or slightly rough; leaves linear, 2-12 cm. \times 1-5 mm., folding inwards slightly and the margins recurving on drying; midrib present, especially towards the base, but scarcely conspicuous; ligule membranous,

truncate, 1 mm. long. *Distribution*: Coast district and dividing range. Pasture species.

Anatomical characters: (Very similar to *Bothriochloa decipiens* and *Dichanthium sericeum* in structure, cf. Text-figs. 1-3.) Leaf fairly thin; both surfaces flat; motor cell groups of the upper epidermis interrupted over every second, third, or fourth bundle; lower epidermis papillate; stomates on both surfaces, more numerous on the lower surface, but also occurring at the edges of the motor cell groups on the upper surface; chlorenchyma, vascular bundles, and stereome as in the above types. *Locality*: Liverpool.



Text-figs. 1-6.*

1.—*Dichanthium sericeum*. $\times 38$. 2.—*Bothriochloa decipiens*. $\times 38$. 3.—*Bothriochloa decipiens*. $\times 150$. 4.—*Cymbopogon refractus*. $\times 38$. 5.—*Cymbopogon bombycinus*. $\times 38$. 6.—*Cymbopogon bombycinus*. $\times 150$.

* In the lower magnification drawings, vascular bundles are stippled, stereome shown as black, chlorenchyma unshaded, motor cells and colourless parenchyma cells shown in detail, and air cavities indicated by horizontal lines. The following explanation of the lettering applies to all the Text-figures: A, asperity; B, colourless tissue; VB, vascular bundle; C, chlorenchyma; MC, motor cells; D, air cavity; UE, upper epidermis; LE, lower epidermis; F, stereome; G, groove; L, papilla; M, midrib; P, phloem; R, ridge; S, bundle sheath; IS, inner bundle sheath; OS, outer bundle sheath; St, stomate; U, first order bundle; W, third order bundle; MX, metaxylem vessels; PX, protoxylem vessels.

AMPHILOPHIS INTERMEDIA Stapf.

(Syn. *Andropogon intermedius* R.Br., *Andropogon punctatus* Roxb., according to Maiden and Betcher's Census of N.S.W. Plants.)

Erect, tufted perennial, 60–100 cm. high, producing a rather small amount of flag; nodes mostly ciliate, to almost glabrous; sheaths rather striate, smooth, glabrous, slightly flattened upwards; leaves linear, narrow, 12–25 cm. \times 2–5 mm., glabrous, smooth or with somewhat rough margins, sometimes slightly glaucous, the leaf folding somewhat and the margins recurving on drying; midrib fairly prominent; ligule membranous, short, truncate, jagged or ciliate. *Distribution*: Tableland to the interior. Pasture species.

Anatomical characters: (Resembles *Bothriochloa decipiens* in type, cf. Text-figs. 2 and 3.) Leaf fairly thin; both surfaces flat; upper epidermis consisting of elongated groups of motor cells, interrupted over about every fourth bundle; motor cells of similar size, the central ones of the group slightly larger, occupying nearly half the thickness of the leaf. A few colourless cells may occur below the motor cells; lower epidermal cells with only moderately thick outer walls, arched or prominently papillate, the cell below a stomate often rather more swollen than the others; stomates present on both surfaces, more numerous on the lower surface; chlorenchyma regular; bundle sheath single, forming a circular layer around the bundles. About 9–13 bundles of the first order occur, with 3–10 bundles of the third order between each, the central one of which may be a little larger than the others; midrib conspicuous with a group of colourless cells above the midvein and associated bundles; stereome very weakly developed as a small group of fibres above and below bundles of the first order forming girders, and as extremely small groups of about 1–5 fibres below, and occasionally above about every fourth bundle of the third order. *Localities*: Richmond, Sydney Botanic Gardens, Blair Athol (Q.).

CYMBOPOGON.

CYMBOPOGON REFRACTUS A. Camus. (Syn. *Andropogon refractus* R.Br.)

Erect, tufted perennial, 45–120 cm. high, producing a fair amount of flag; stem bases slightly aromatic when dry; nodes glabrous; sheaths glabrous, smooth to scabrous; leaves narrow, linear, tapering to filiform points, 7–30 cm. \times 1–4 mm., glabrous, scabrous downwards, and with scabrous margins, folding somewhat and the margins recurving on drying; ligule membranous, truncate, often jagged, 1 mm. long. *Distribution*: Coast districts to west of the Divide. Pasture and forest species.

Anatomical characters: (Text-fig. 4.) Leaf moderately thin; upper surface flat; lower surface undulating with low ridges below the bundles which are occupied by small groups of fibres; upper epidermis consisting of elongated groups of about 4–8 motor cells, the groups interrupted by a few smaller epidermal cells over bundles of the first and second order; motor cells all of similar size, the central one of the group slightly larger, occupying one-third to one-half the thickness of the leaf. A few colourless cells may occur below the motor cells; lower epidermal cells with moderately thick, arched outer walls, with occasional short pointed emergences especially on the sides of the ribs; stomates almost entirely on the lower surface; chlorenchyma regular; bundle sheath single, forming a circular layer. About 7 bundles of the first order occur, with 3–7 bundles of the third order between each; midrib conspicuous in section, with a group of colourless cells placed above the midvein and associated bundles;

stereome developed as a group of fibres above and below bundles of the first order forming girders with them, and as a small group below, but not attached to each bundle of the third order, causing ribbing of the lower surface. *Localities*: Warialda, Rookwood, Homebush.

CYMOPOGON BOMBYCINUS Domin. (Syn. *Andropogon bombycinus* R.Br.)

Erect, rigid, tufted perennial, producing a fair amount of flag, 45–120 cm. high; bases of the stems slightly aromatic when dry; nodes ciliate or glabrous; sheaths glabrous, or pubescent in the lower part, smooth to slightly rough; leaves narrow, linear, 7–30 cm. \times 2–6 mm., rather rigid, glabrous, rough, flat, folding and the margins recurving on drying; midrib noticeable at the base only or not at all; ligule membranous, rather prominent, entire, 1–5 mm. long. *Distribution*: Interior, extending to the tablelands. Pasture species.

Anatomical characters: (Text-figs. 5 and 6; resembles *Cymbopogon refractus* in type.) Leaf moderately thin; upper surface practically flat; lower surface with low ribs occupied by small groups of fibres below almost every bundle; upper epidermis consisting of elongated groups of about 4–10 motor cells, the groups interrupted by smaller epidermal cells over bundles of the first order; motor cells of similar size, the central ones slightly larger, occupying nearly half the leaf thickness. A few colourless cells may occur below the motor cells; lower epidermal cells with moderately thick, arched outer walls, bearing a few pointed emergences (asperities) on the ridges; chlorenchyma regular; stomates almost entirely on the lower surface, few on the upper surface; bundle sheath single, forming a circular layer. About 7 bundles of the first order occur, with about 3–7 bundles of the third order between each; midrib small or conspicuous, often with a group of colourless cells above the midrib and associated bundles; stereome developed as a small group of fibres above and below bundles of the first order, forming short girders with them, and also as small groups below bundles of the third order, occupying the ridges, but not forming girders. *Localities*: Warialda, Laverton (W.A.), Bourke, McDonnell Ranges.

This species may also produce filiform leaves, in which the blades are reduced to an enlarged midrib structure, with a large mass of colourless tissue above the bundles, and barely any expanded lateral regions. The bundles are placed around the lower edges of this structure, and are surrounded by chlorenchyma as in the flat leaves. About 7 first order bundles occur, with 3–4 bundles of the third order between each. The lower surface is ribbed. A few large epidermal cells (resembling motor cells) occur along the upper surface, between patches of fibrous tissue. (Cf. Text-fig. 7.) *Locality*: Broken Hill.

CYMOPOGON EXALTATUS Domin. (Syn. *Andropogon exaltatus* R.Br.)

Erect, stiff, tufted, glabrous, perennial, 30–200 cm. high, forming flag; stem bases scented when dry; nodes glabrous; shoots often rather flattened with the leaf sheaths also flattened towards the base; leaves long, narrow linear to filiform, 15–45 cm. \times 2–5 mm., the flat leaves rolling on drying, scabrous downwards or smooth with scabrous margins; midrib noticeable in the flat leaves, the leaves reduced to an enlarged midrib region in the filiform types; ligule membranous, acute, 3–6 mm. long. *Distribution*: Western districts. Pasture species; rare.

Anatomical characters: (Similar in type to *Cymbopogon refractus*, cf. Text-figs. 4, 5, 6.) Upper surface practically flat; lower surface with distinct low ribs containing groups of fibres below almost every bundle; upper epidermis

consisting of elongated groups of about 4-10 motor cells, interrupted by small epidermal cells over each bundle of the first order, and occasionally, where the larger bundles are widely spaced, over bundles of the third order also; motor cells all of a similar size, the central ones of each group slightly larger, occupying about half the thickness of the leaf. A few colourless cells may occur below the motor cells; lower epidermis of small cells with rather thick, slightly arched outer walls, bearing some asperities, especially on the ribs; stomates mostly in the grooves on the lower surface, a few on the upper surface; chlorenchyma regular; bundle sheath single, forming a circular layer. About 7-11 bundles of the first order occur, with 3-7 bundles of the third order between each; midrib conspicuous with a mass of colourless tissue above the midvein and associated bundles; stereome developed as a mass of fibres above and below bundles of the first order, forming girders with them, and also as groups of fibres occupying the ribs below each bundle of the third order, but not usually connected with them. *Localities*: Castle Hill near Townsville (Q.); Western Australia.

This species also produces filiform leaves which are reduced to an enlarged midrib region with a mass of colourless cells above all the bundles, the lateral expanded parts of the blade almost or entirely reduced (Text-fig. 7). *Locality*: Broken Hill (2 collections).

All gradations may occur between these two forms. Stomates may be entirely absent from the upper surface of the filiform and intermediate forms. Groups of enlarged cells resembling motor cells may still be present in the reduced types. *Localities of intermediate forms*: Broken Hill, Torrawangee.

HYPARRHENA.

HYPARRHENA FILIPENDULA Stapf.

(Syn. *Andropogon filipendulus* Hochst. according to Maiden and Betcher's Census of N.S.W. Plants, *Andropogon filipendulus* var. *lachnantherus* Hack., *Andropogon lachnantherus* Benth.)

Erect, tufted perennial, 60-120 cm. high, producing a considerable amount of flag; stem bases scented when dry; nodes glabrous; sheaths smooth, mostly glabrous; leaves linear, narrow, 10-25 cm. \times 1-4 mm., rather flat, folding somewhat and the margins recurving on drying, glabrous or with a few scattered hairs, slightly rough to scabrous downwards; midrib usually noticeable, often light coloured; ligule membranous, 1-2 mm. long, or ciliate. *Distribution*: Northern coast, tablelands, and western slopes. Pasture species.

Anatomical Characters: (Text-fig. 8.) Resembles *Dichanthium sericeum* in type; leaf fairly thin; both surfaces flat; upper epidermis consisting of elongated groups of 3-10 motor cells interrupted by small epidermal cells over about every second or fourth bundle; motor cells of somewhat similar size, the central ones progressively larger, and occupying nearly half the thickness of the leaf; lower epidermis of fairly small cells with moderately thick, arched or papillate outer walls, bearing occasional asperities, the cells below a stoma often more prominently papillate; stomates mostly on the lower surface; chlorenchyma regular; bundle sheath single, forming a circular layer. About 7-9 bundles of the first order occur, with 3-7 bundles of the third order between each; midrib fairly conspicuous; stereome very weakly developed as small groups of fibres forming girders with bundles of the first order, and as extremely small groups below, and sometimes above about every second bundle of the third order, rarely connected to them. *Localities*: Warialda, Copmanhurst.

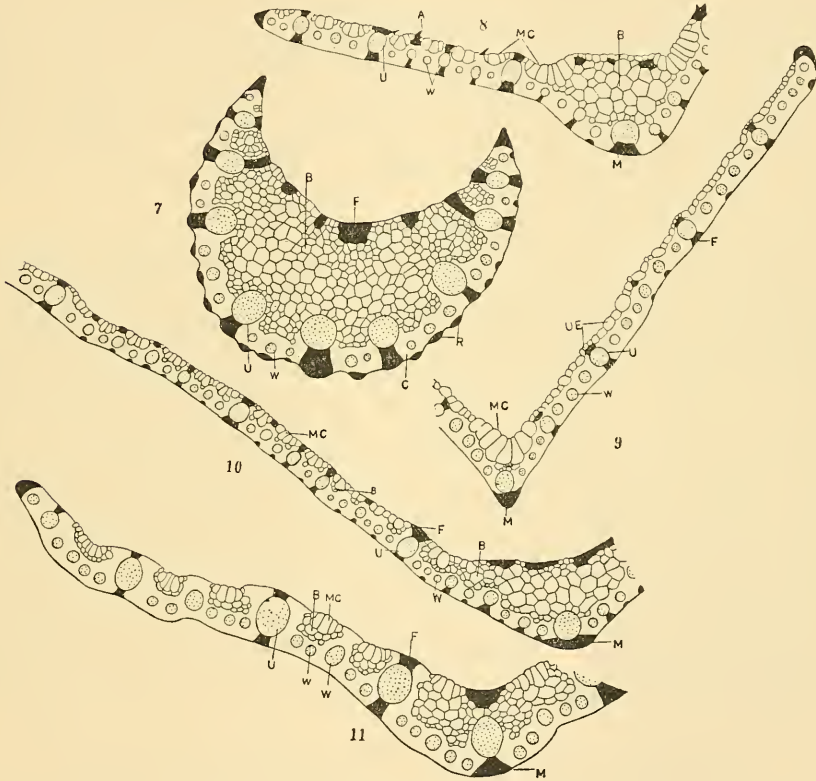
SCHIZACHYRIUM.

SCHIZACHYRIUM OBLIQUIBERBE A. Camus.

(Recorded from N.S.W. as *Andropogon brevifolius* Swartz, and *A. fragilis* R.Br.)

Rather small tufted plant, 15-45 cm. high, producing little flag; nodes glabrous or shortly pubescent; sheaths fairly smooth, glabrous, flattened especially towards the upper end; leaves rather short, 2-15 cm. \times 2-4 mm., glabrous, smooth to rough, folding on drying, the margins rarely recurving; ligule membranous, truncate, 0.2-1 mm. long. *Distribution*: Northern coast and tablelands; rare in N.S.W.

Anatomical characters: (Text-fig. 9.) Leaf fairly thin; both surfaces flat; upper epidermis of fairly large and moderately thin-walled cells, alternating with a very few smaller cells over the larger bundles, the larger cells occupying one-quarter to one-third of the thickness of the leaf, but hardly organized as groups of motor cells. A group of large motor cells occurs above the midrib, the leaf



Text-figs. 7-11.

7.—*Cymbopogon exaltatus*. T.S. filiform leaf, which is reduced to an enlarged midrib region. \times 38. 8.—*Hyparrhena filipendula*. \times 38. 9.—*Schizachyrium obliquiberbe*. \times 38. 10.—*Capillipedium parviflorum*. \times 28. About one-third of the transverse section. 11.—*Chrysopogon Gryllus*. \times 38.

being prominently keeled and folding on drying; lower epidermal cells with moderately thin, arched to papillate outer walls, the cells about half to two-thirds the size of the larger cells of the upper epidermis; stomates on both surfaces, rather more numerous on the lower surface; chlorenchyma regular; bundle sheath single, forming a circular layer. About 7-9 bundles of the first order occur, with 4-7 bundles of the third order between each; midrib conspicuous though not large; stereome very weakly developed as a small group of fibres above and below bundles of the first order forming girders, and above and below, or only below, about every third or fourth bundle of the third order, but not forming girders. *Localities*: Copmanhurst, Narrabri West, Tambourine Mt. (Q.), near Cape River east of Pentland (Q.).

CAPILLIPEDIUM.

CAPILLIPEDIUM PARVIFLORUM Stapf.

(Syn. *Chrysopogon parviflorus* Benth., *C. parviflorus* var. *spicigera* Benth., *C. violascens* Trin., *Andropogon micranthus* Kunth.)

Large, tufted perennial, 60-120 cm. high, producing a considerable amount of flag; nodes conspicuously bearded to glabrous; sheaths glabrous or with rather long, scattered hairs, somewhat keeled in the upper part, open, but closely wrapped around the stem, or finally slipping from the stem; leaves linear, narrow, 12-30 cm. \times 2-6 mm., glabrous, smooth to scabrous, especially on the upper surface, margins, and midrib region, inrolling on drying, or sometimes folding slightly and the margins recurving; midrib present, conspicuous at least at the base; ligule ciliate, the cilia often long. *Distribution*: Coast to tablelands and western slopes. Pasture species.

Anatomical characters: (Text-fig. 10.) Leaf wide, thin; both surfaces flat or almost so; upper epidermis of groups of 3-6 motor cells, interrupted by small epidermal cells over about every second bundle; motor cells of similar size, the central few of the group slightly larger, occupying one-third to one-half the thickness of the leaf. A few colourless cells may occur below the motor cells, especially between the bundles; lower epidermal cells with only moderately thick, arched to papillate outer walls, sometimes with scattered asperities, the cell below a stomate usually more prominently papillate; pointed hairs sometimes present on both surfaces; stomates mostly on the lower surface, few on the upper surface; chlorenchyma regular; bundle sheath single, forming a circular layer. About 9-13 bundles of the first order occur, with about 5-11 bundles of the third order between each; midrib conspicuous with a mass of colourless tissue above the midvein and associated bundles; stereome very weakly developed as a small mass of fibres above and below first order bundles, forming girders, and as extremely small hypodermal groups of about 1-6 fibres above and below about every second bundle of the third order, and occasionally below a few others, but usually not forming girders with the third order bundles. *Localities*: Warialda (3 collections), Glenbrook.

CHRYSOPOGON.

CHRYSOPOGON GRYLLUS Trin. (Syn. *Andropogon Gryllus* L.)

Erect, tufted perennial, 45-120 cm. high, producing some flag; nodes glabrous; base of the stem swollen and woolly-hairy in western specimens, but not in the coastal and highland specimens; sheaths sometimes flattened, the upper culm sheaths glabrous and smooth, the lower ones often woolly hairy around the

swollen stem bases; leaves linear, 7-25 cm. \times 1-4 mm., sometimes almost filiform, glabrous or with few scattered hairs, slightly rough or smooth, inrolling on drying, occasionally also the margins recurving; midrib present; ligule composed of a few cilia, or truncate membranous, jagged, very short. *Distribution*: Tableland to the interior. Pasture species.

Anatomical characters: (Text-fig. 11.) Leaf of moderate thickness; both surfaces flat, or the upper surface very slightly undulating over the larger bundles; upper epidermis consisting of small, flat, moderately thick-walled cells over the larger bundles, with isolated groups of 3-6 motor cells between, the groups sometimes slightly arched at the surface. A row of colourless cells may occur beneath the motor cells which, together with the motor cells, occupy about half the thickness of the leaf; motor cells progressively larger towards the centre of the group; lower epidermal cells small, with fairly thick, flat or slightly arched outer walls, similar in size to the smaller cells of the upper epidermis, and forming a fairly compact layer; stomates frequent on both surfaces; chlorenchyma regular; bundle sheath single, forming a circular layer. About 7-9 bundles of the first order occur, with about 2-6, usually 5 bundles of the third order between each; midrib often conspicuously developed with a mass of colourless cells above the midvein and associated bundles; stereome extremely weakly developed as a rather small mass above and below bundles of the first order forming girders. There is usually no fibre associated with even the larger third order bundles. *Localities*: Warialda (2 collections), Coolabah.

VERTIVERIA.

VERTIVERIA ELONGATA C. E. Hubbard.

(Syn. *Chrysopogon elongatus* Benth., *Chrysopogon Gryllus* var. *spicigera* Maiden and Betche.)

Rather large, tufted perennial, 60-120 cm. high; base of the shoots and the sheaths very prominently flattened; nodes glabrous, depressed; sheaths glabrous, almost smooth; leaves linear, 10-30 cm. \times 2-8 mm., slightly folded, rather striate, almost glabrous; midrib prominent; ligule very short, membranous, truncate. *Distribution*: North coast to west of the divide. Probably a hygrophilous species, often on river sands.

Anatomical characters: (Text-fig. 12.) Leaf rather thick; both surfaces flat, or occasionally the lower surface very slightly undulating; leaf folded on drying, with large air cavities between the larger bundles; upper and lower epidermis of small cells with rather thick, flat or very slightly arched outer walls. A group of large motor cells occurs over the midrib, subtended by a number of colourless cells; occasionally a few motor cell-like groups also occur towards the margins of the leaf. Colourless cells form a more or less continuous band under the upper epidermis, over the air spaces and between the larger bundles and the upper epidermis, the cells above the bundles more or less lignified, grading into fibrous tissue. The air cavities and parenchyma together occupy half to three-quarters of the leaf thickness; stomates numerous on both surfaces; chlorenchyma of rather short rounded cells arranged rather regularly in a row around the somewhat closely spaced bundles, but with other similar cells between, sometimes grading into the colourless cells of the upper side of the leaf; bundle sheath single, forming a circular layer; bundles of three types: first order, large third order, and small third order bundles. About 11 bundles of the first order occur, with a similar number of large third order bundles alternating with them, and one,

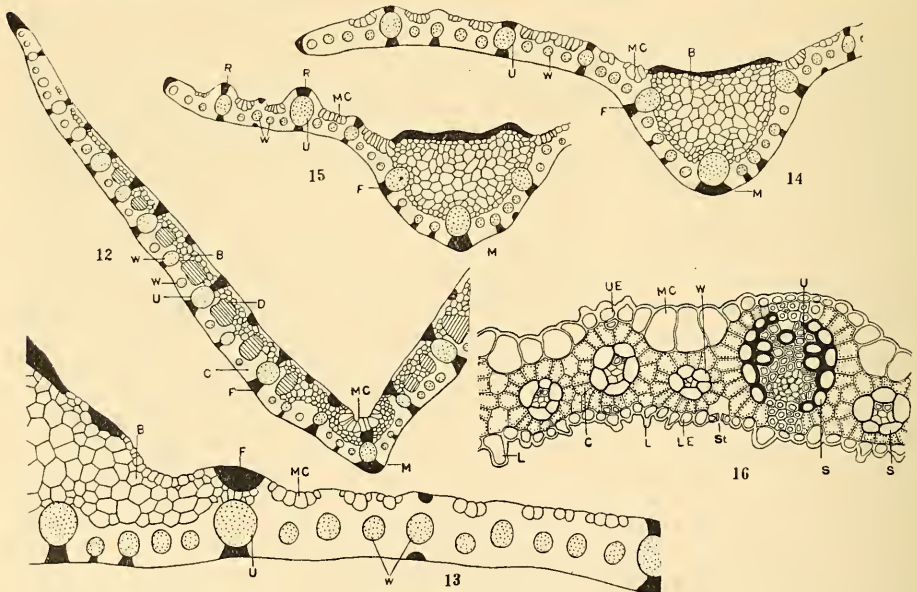
rarely two, small third order bundles between each of the above; midrib small but conspicuous owing to the folding of the leaf and position of the motor cells; stereome rather weakly developed as small groups below the larger bundles (of first and third order), and also above them, where it may grade into the parenchyma cells, thus forming girders. *Localities*: Orara River at Bawden Bridge in river sands, Tabulam, Greenridge, Narrabri.

SORGHUM.

SORGHUM HALEPENSE Pers. (Syn. *Andropogon halepensis* Sibth. and Smith.)

Tall, erect perennial, 75–180 cm. high, tufted and also producing rhizomes; nodes glabrous or very shortly ciliate; sheaths finely striate, long, smooth; leaves linear, wide, 12–45 cm. \times 5–15 mm., flat or irregularly folding on drying, striate, with 3–6 conspicuous veins on either side of the midrib, fairly smooth but with scabrous margins; midrib conspicuous, pale coloured; ligule jagged or ciliate. *Distribution*: Coast and tablelands. Often a weed of cultivation.

Anatomical characters: (Text-fig. 13.) Leaf very wide, rather thick, but appearing thin compared with width of leaf; both surfaces flat; upper epidermis consisting of about 2–6 rounded motor cells alternating with groups of smaller epidermal cells; motor cells small, all of similar size, occupying only about one-quarter the thickness of the leaf, becoming less and less clearly distinguished from the other epidermal cells towards the margins of the leaf, not forming a very conspicuous feature of the epidermis; lower epidermal cells of moderate size, rather irregular, with flat or very slightly arched, moderately thick, outer walls; stomates frequent on both surfaces; chlorenchyma regular; bundle sheath single,



Text-figs. 12-16.

12.—*Vertiveria elongata*. \times 28. 13.—*Sorghum halepense*. About one-tenth of the transverse section. \times 38. 14 and 15.—*Sorghum* sp. (*Andropogon australis* var. *leiocladum*), showing variations in the contour of the upper surface. \times 38. 16.—*Sorghum* sp. \times 150.

strongly sclerized around the larger bundles, of slightly larger cells with thinner walls around the small bundles, forming a circular layer. About 19 bundles of the first order occur, with 3-15 bundles of the third order between each; midrib conspicuous, with a large mass of colourless tissue above the midvein and associated bundles; stereome very weakly developed except in the midrib region; a small mass of fibres occurs above and below the first order bundles forming girders, and occasional extremely small groups below, rarely above some of the third order bundles. At the midrib nearly every bundle has a few hypodermal fibres below it, every second one with a large group below and connected with it. A narrow band of fibres also occurs below the upper epidermis at the midrib. *Localities*: Richmond, Homebush.

SORGHUM sp.

(Syn. *Andropogon australis* Spreng. var. *leiocladum* Hackel, *Sorghum plumosum* of Maiden and Betcher's Census of N.S.W. Plants, non Beauv. In a list of determinations sent to me from Kew in 1931, this species was identified as *Sorghum leiocladum* C. E. Hubbard MS, sp. nov., non *S. plumosum*.)

Robust, erect, tufted perennial, 30-100 cm. high, forming abundant flag; nodes conspicuously bearded; sheaths rather flattened in the upper part, pubescent, especially in the upper part, to glabrous, rough; leaves long, linear, narrow, 7-30 cm. \times 2-5 mm., glabrous or somewhat pubescent, scabrous, folding slightly and the margins recurving on drying; midrib present, usually fairly conspicuous; ligule short, membranous, truncate and jagged, or ciliate. *Distribution*: Coast and tablelands. Pasture species.

Anatomical characters: (Text-figs. 14, 15, 16.) Leaf moderately thin; both surfaces flat or nearly so, the upper surface sometimes irregularly undulating on account of low ridges over the bundles; upper epidermis consisting mainly of elongated groups of about 5-10 motor cells interrupted by a few smaller epidermal cells with flat or arched outer walls over every second or fourth bundle; motor cells all of similar size, the central ones of the group rather larger, occupying slightly less than half the thickness of the leaf; lower epidermal cells with only moderately thick outer walls, strongly papillate, and bearing distinct papillae; stomates on both surfaces, more numerous on the lower surface; chlorenchyma regular; bundle sheath single, forming a circular layer. About 5-7 bundles of the first order occur, with 3-7 bundles of the third order between each; midrib usually conspicuous with a large mass of colourless tissue above the midvein and associated bundles; stereome very weakly developed as a small mass of fibres above and below bundles of the first order forming insignificant girders, and as extremely small groups of about 1-5 fibres above and below about every second or fourth bundle of the third order but usually not connected to it. Sometimes a small mass occurs below almost every bundle in the midrib region. *Localities*: Prospect, Camden, Barrington Tops, Warrialda.

ARTHRAxON.

ARTHRAxON CILIARIS Beauv. var. AUSTRALIS Benth.

Creeping, stoloniferous perennial, ascending 30-45 cm.; leaves all on the culms, no flag produced; sheaths with scattered long hairs; leaves lanceolate, or cordate at the base, acute or acuminate, 10-30 cm. \times 5-10 mm., smooth, glabrous or ciliate at the margins, flat, not rolling or folding freely on drying; midrib distinct, veins widely spaced; ligule membranous, not long. *Distribution*: New England, in swamps; rare.

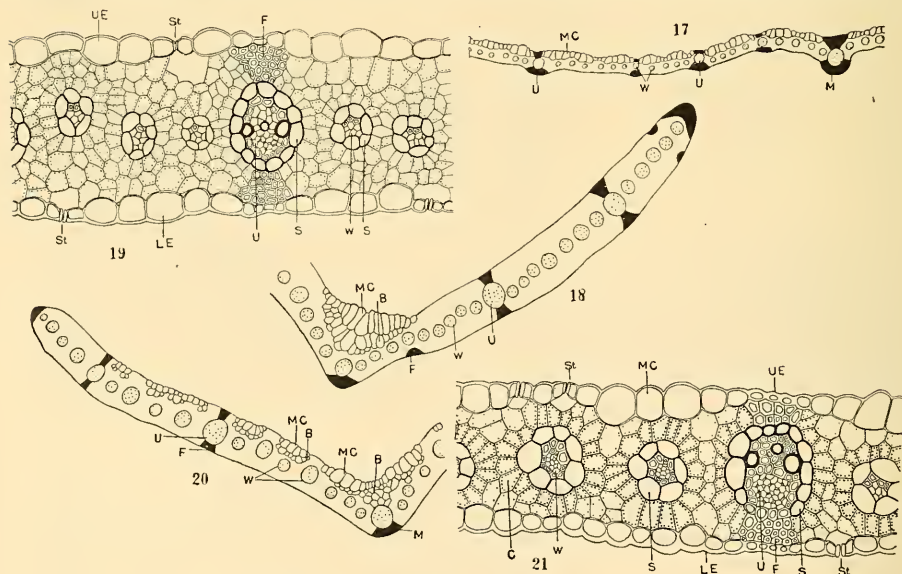
Anatomical characters: (Text-fig. 17.) Leaf very thin, wide; both surfaces flat, upper epidermis almost entirely composed of very elongated groups of large motor cells occupying half the thickness of the leaf, interrupted by a very few smaller cells over the larger bundles and occasionally over a third order bundle; motor cells of similar size; lower epidermal cells with only moderately thick to rather thin outer walls, flat to slightly arched or even somewhat papillate, occasionally bearing rather long pointed hairs, the cells much smaller than those of the upper epidermis; stomates mostly on the lower surface; chlorenchyma fairly regular, but the bundles slightly more widely spaced than in such types as *Bothriochloa decipiens*; bundle sheath single. About 13 bundles of the first order occur, with 5-20, often 17, bundles of the third order between each, a few of which are rather larger and associated with fibre groups; midrib rather small, not conspicuous, consisting of a rather large bundle with a small group of fibres above it, and a large group below it projecting on to the lower surface, so that the leaf is keeled; stereome developed as a rather broad mass below the first order bundles, and as a narrower mass above them forming girders; a smaller mass occurs below about every fourth or sixth bundle of the third order, but is not connected to it. *Localities*: New England, Stradbroke Is. (Q.). Dried material only examined.

EREMOCHLOA.

EREMOCHLOA MURICATA Hack.

(Syn. *Ischaemum pectinatum* Trin., *Rottboellia muricata* Retz.)

Small, tufted perennial, ascending 15-45 cm.; leaves mostly at the base; culms angular; shoots prominently flattened; sheaths strongly flattened, glabrous, smooth, striate; nodes shortly ciliate to almost glabrous; leaves linear, usually



Text-figs. 17-21.

17.—*Arthraxon ciliaris*. About one-eighth of the transverse section. $\times 27$. 18.—*Eremochloa muricata*. $\times 38$. 19.—*Eremochloa muricata*. $\times 150$. 20.—*Hemarthria uncinata*. $\times 38$. 21.—*Hemarthria uncinata*. $\times 150$.

short, 2-8 cm. \times 1-3 mm., occasionally up to 15-20 cm. long, folded on drying, covered with short, scattered hairs, smooth to slightly rough; ligule membranous, truncate, short, 1 mm. long, often also with a few cilia at the orifice. *Distribution*: North Coast to tablelands. Pasture species, often in slight depressions where drainage collects.

Anatomical characters: (Text-figs. 18 and 19.) Leaf of moderate thickness, folded on drying; both surfaces flat; upper epidermis of moderately thin to rather thick-walled, arched or sometimes papillate cells all of similar size, with a group of large motor cells above the midrib, which are subtended by a few other colourless cells; lower epidermal cells only slightly smaller than those of the upper epidermis, the outer walls not strongly arched; stomates on both surfaces; chlorenchyma semi-regular in type, the bundles being fairly closely spaced, but more than one layer of chlorenchyma present between the bundles and the epidermis; bundle sheath single; midrib small, but conspicuous on account of the folding of the leaf and the position of the motor cells above it; stereome very weakly developed as a small group of fibres above and below the first order bundles forming small girders, and rarely as an extremely small group below a very few of the third order bundles. *Localities*: Warialda, Tenterfield, Wallangra, Wallangarra, Byron Bay. In the specimen from Byron Bay, a hypodermal row of colourless cells occurs under the upper and lower epidermis, interrupted only at the first order bundles.

HEMARTHRIA.

HEMARTHRIA UNCINATA R.Br.

(Syn. *Hemarthria compressa* Benth., *Fl. Aust.*, non R.Br., *Rottboellia compressa* Beauv.)

Perennial, creeping, or decumbent at the base, ascending 30-60 cm.; nodes glabrous; sheaths glabrous or ciliate along the margins; leaves linear, narrow, 2-20 cm. \times 2-5 mm., glabrous or with few cilia, smooth, folding, and sometimes the margins recurving when dry; midrib not prominent, but visible near the base; ligule minute, truncate, or almost absent. *Distribution*: Coast district and tablelands. Usually in moist situations.

Anatomical characters: (Text-figs. 20 and 21.) Leaf moderately thin; both surfaces flat; upper epidermis composed of fairly small cells with moderately thick, slightly arched outer walls, interrupted towards the centre half of the leaf by groups of motor cells, which are absent or scarcely distinguishable from epidermal cells towards the margins of the leaf; motor cells usually in groups of 4 or 5, all of similar size, the central ones only a little larger than the lateral ones, not very big, occupying only about one-quarter to one-third of the leaf thickness; a more conspicuous group of motor cells often occurs on either side of the midrib. Colourless cells may occur beneath the motor cells, at times forming an almost complete hypodermal band; lower epidermis of medium-sized cells with moderately thick, flat or slightly arched outer walls; stomates numerous on both surfaces, especially on the lower surface; chlorenchyma regular; bundle sheath single, forming a circular layer. About 5 bundles of the first order occur, with 5-7 bundles of the third order between each; midrib usually not large, but noticeable on account of the leaf folding at this point; stereome very weakly developed as a small group of fibres above and below bundles of the first order forming weak girders, usually none associated with the third order bundles. *Localities*: Homebush (3 collections), Taronga Park, Dapto, Guyra, Mt. Lofty (S.A.).

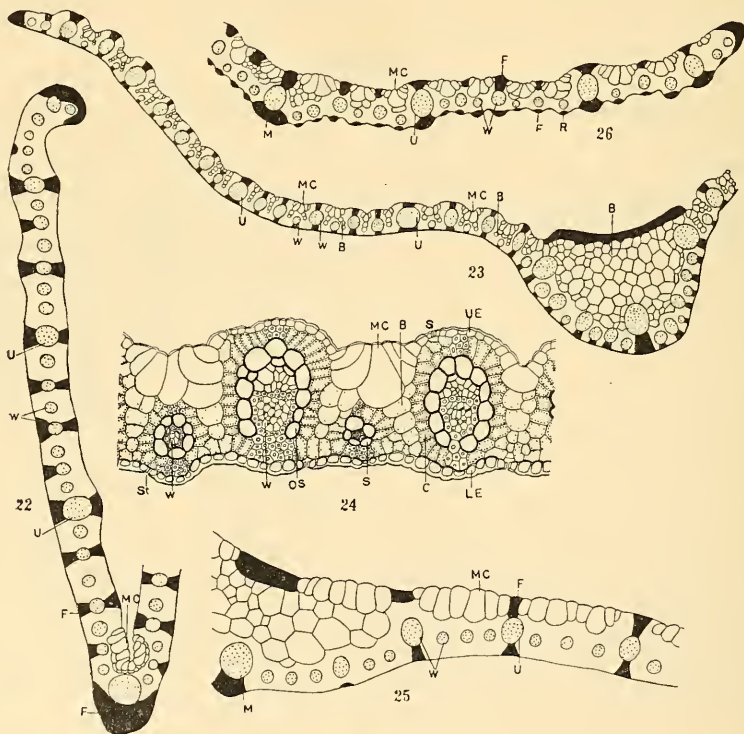
HETEROPOGON.

HETEROPOGON HIRTUS Pers.

(Syn. *Heteropogon contortus* Roem. and Schult., *Andropogon contortus* L.)

Erect or ascending, tufted perennial, 60–100 cm. high, producing a fair amount of flag; nodes glabrous; culms angular, shoots flattened; sheaths distinctly flattened, sometimes striate, glabrous; leaves linear, 5–25 cm. \times 2–10 mm., folded on drying, glabrous, smooth to scabrous, often slightly glaucous; midrib mostly fairly conspicuous, at least in the lower part, but not large; ligule short, membranaceous, truncate. *Distribution*: North Coast and tablelands. Pasture and forest species.

Anatomical characters: (Text-fig. 22.) Leaf rather thin, folding on drying; both surfaces flat, or with slight protuberances over the larger bundles; upper epidermis of cells very irregular in size, with moderately thick, flat or arched outer walls, a few cells papillate; a few asperities sometimes present on both surfaces; stomates frequent on both surfaces, especially on the lower surface; chlorenchyma regular around the very closely spaced bundles; bundle sheath single, forming a circular layer. About 9 bundles of the first order occur, with 3–7 bundles of the third order between each; midrib conspicuous on account of



Text-figs. 22–26.

22.—*Heteropogon hirtus*. \times 38. 23.—*Imperata cylindrica* var. *Koenigii*. \times 28.
24.—*Imperata cylindrica* var. *Koenigii*. \times 150. 25.—*Ischaemum australe*. About
one-eighth of the transverse section. \times 38. 26.—*Ischaemum laxum*. \times 38.

the motor cells situated above it, and a mass of fibres below, giving the leaf a prominent, acutely pointed keel. The midrib may be small with a few colourless cells above it, or larger with a big group of colourless tissue and more than one group of motor cells (usually 2-3) above it; stereome moderately developed as masses of fibres forming girders with bundles of the first order, and usually every second, occasionally every fourth bundle of the third order, and as a large mass below the midrib. *Localities*: Warialda, Copmanhurst, Brisbane (Q.).

IMPERATA.

IMPERATA CYLINDRICA var. KOENIGII Durand and Schinz.

(Syn. *Imperata arundinacea* Cyr., not the typical form.)

Stiff, erect perennial, 30-90 cm. high, propagating by means of rhizomes with long internodes, so that each shoot arises singly or in small tufts, not forming large tufts; nodes ciliate; sheaths glabrous, except for a few hairs often present near the ligule; leaves mostly from the base, stiff, ascending, very long, up to 90 cm. \times 3-10 mm., linear or very narrow lanceolate, tapering at both ends, glabrous, slightly scabrous on the upper surface and margins, folding and the margins inrolling on drying; midrib conspicuous, often slightly excentric, prominent and thick towards the base where it constitutes almost the whole blade; ligule ciliate, with long hairs at the sides. *Distribution*: Throughout the State, especially in coastal districts, where it is often found on poor sandy soils.

Anatomical characters: (Text-figs. 23 and 24.) Leaf wide, thin; both surfaces usually flat, or the upper surface slightly and irregularly undulating over the larger bundles; upper epidermis consisting of small cells with rather thick, flat or arched outer walls over the bundles, alternating with rather short groups of 3-6 motor cells, the central one of which is usually much larger than the lateral ones, and occupies one-third to barely one-half the thickness of the leaf. Colourless cells or cells with few chloroplasts usually occur below the motor cells, tending to form a row downwards towards the lower surface, or, where the motor cell groups occur over a small bundle, two rows of these colourless cells may be produced from the motor cell group, one row on either side of the bundle; lower epidermis of small thick-walled cells, the outer walls flat or only slightly arched; stomates on both surfaces, rather more numerous on the lower surface; chlorenchyma of rather short, rounded cells arranged in a somewhat irregular row around the bundles which are only moderately closely spaced, often with a number of additional cells between the rows; bundle sheath of two layers, at least around the largest bundles, the inner layer very strongly sclerized, the outer thinner-walled, especially around bundles of the third order, forming a circular or oval layer; bundles of three distinct sizes, large first order bundles, medium-sized bundles of the third order, and small third order bundles. About 11-13 bundles of the first order occur, with about 3-9 (often 7) bundles of the third order between each, of which every second is a large third order bundle. Midrib always conspicuous, with a large mass of colourless tissue above the midvein and associated bundles, the lower narrowed part of the leaf consisting almost entirely of an enlarged midrib region; stereome moderately well developed, forming narrow girders with the first order and most of the third order bundles, often with the smaller bundles. Even if no girder is formed, the small third order bundles at least have small groups of fibres below them. The stereome is particularly strongly developed in the narrow, lower part of the leaf. *Localities*: Pennant Hills, Pittwater, Rookwood, National Park.

ISCHAEMUM.

ISCHAEMUM AUSTRALE R.Br.

Creeping, stoloniferous or slightly tufted perennial, the shoots ascending 30–75 cm., rather slender; nodes slightly swollen, prominently ciliate, but the hairs tend to rub off in older specimens; sheaths glabrous, smooth, somewhat flattened, especially towards the upper end; leaves linear to linear-lanceolate, 5–15 cm. \times 5 mm., smooth but slightly scabrous along the margins; midrib present; ligule membranous, truncate or acute, sometimes splitting into two acute lateral lobes, 2–4 mm. long. *Distribution*: Northern coast district.

Anatomical characters: (Text-fig. 25.) The anatomy as seen in transverse section conforms to the general *Dichanthium* and *Bothriochloa* type, but the leaf is wider. Leaf moderately thick, or appearing thin on account of width of leaf; both surfaces flat or almost so; upper epidermis of rather elongated groups of 4–7 motor cells interrupted or partly so over about every third or fourth bundle; motor cells of similar size, the central ones of the group rather larger and occupying nearly half the thickness of the leaf; lower epidermis of strongly papillate cells whose outer walls also have simple, or sometimes multiple lobed papillae on them; stomates mostly on the lower surface; chlorenchyma regular; bundle sheath single, forming a circular layer. About 11–13 bundles of the first order occur, with 3–13 bundles of the third order between each; midrib conspicuous, with a mass of colourless tissue above the midvein and associated bundles; stereome weakly developed as small masses forming girders with the larger bundles, and very small groups above and below occasional third order bundles. *Localities*: Trial Bay; Manning River. Dried specimens only examined.

ISCHAEMUM TRITICEUM R.Br.

Creeping, stoloniferous perennial, the shoots ascending 30–60 cm.; nodes somewhat swollen, usually ciliate; sheaths usually hairy, especially on the margins, or glabrous, fairly smooth, rather flattened in their upper part; leaves linear to narrow lanceolate-ovate, sometimes slightly cordate at the base, 5–20 cm. \times 4–5 mm., slightly hairy, smooth but with scabrous margins, especially towards the apex; midrib present; ligule membranous, truncate, 1–2 mm. long, often forming auricles at the top of the sheath. *Distribution*: Northern coast district.

Anatomical characters: The anatomy as seen in transverse section appears almost identical with that of *I. australe*. Leaf wide, flat; upper epidermis of elongated groups of 4–9 motor cells which occupy most of the upper surface; lower epidermis, stomates, chlorenchyma, bundle sheath and stereome as in *I. australe*. About 11–17 bundles of the first order occur, with about 5–17 bundles of the third order between each. *Localities*: Burringbar, Port Macquarie. Dried specimens only examined.

ISCHAEMUM LAXUM R.Br.

(Syn. *Andropogon nervosus* Rottb., *Schima nervosum* Stapf.)

Erect, tufted, rather slender perennial, about 45 cm. high; nodes glabrous or ciliate; sheaths very slightly flattened, with scattered hairs, finely striate; leaves 10–25 cm. \times 2–4 mm., tapering to filiform points, glabrous, rough; midrib distinct, whitish; ligule ciliate with rather long hairs. *Distribution*: Northern coast district and tablelands.

Anatomical characters: (Text-fig. 26.) Leaf fairly thin; upper surface flat, or very slightly undulating; lower surface slightly and closely undulating with a small group of fibres occupying the ridges below each bundle; upper epidermis

composed of groups of about 5 motor cells, interrupted over every second bundle by small thick-walled epidermal cells which often bear short pointed emergences; the central one or two motor cells conspicuously larger than the lateral ones, the group thus broadly triangular, and occupying rather more than half the leaf thickness; lower epidermis of small, very thick-walled cells, usually with flat outer walls, and bearing a number of emergences, especially on the sides and tops of the ridges; chlorenchyma regular; bundle sheath single, forming a circular layer. About 7 bundles of the first order occur, with 3-7 bundles of the third order between each, of which every second is slightly larger; stereome weakly developed as a rather wide but thin mass above and below bundles of the first order forming girders, and as a small mass below each third order bundle, occupying the ridges on the lower surface, and as a few hypodermal fibres above every second bundle of the third order. *Locality*: Castle Hill near Townsville (Q.).

ISEILEMA.

ISEILEMA MEMBRANACEA Domin.

(Syn. *Iseilema Mitchelli* Anderss., *Anthistiria membranacea* Lindl.)

Small, tufted, ascending, usually annual grass, 7-45 cm. high, glabrous; nodes glabrous; culms angular; sheaths prominently flattened, striate, smooth or slightly rough; leaves flat or folded, 1-10 cm. \times 2-6 mm., rather rough downwards; midrib only conspicuous on account of the folding of the leaf; ligule short, membraneous, truncate. *Distribution*: Interior. Pasture species.

Anatomical characters: (Text-figs. 27 and 28.) Leaf thin, folding on drying; both surfaces flat. The main group of thin-walled motor cells occurs over the midrib, with a small mass of colourless tissue below it, but the upper epidermis also has groups of 2-3, rarely 4, large, almost circular, motor-cell-like cells whose walls are only moderately thick, and slightly arched or slightly papillate, interrupted over every second bundle, and occupying slightly more than one-third of the thickness of the leaf; lower epidermis of rather irregular sized cells, only moderately thick-walled and slightly arched to slightly papillate; stomates on both surfaces, more numerous on the lower surface; chlorenchyma regular; bundle sheath single, forming a circular layer. About 7 bundles of the first order occur, with about 3-9, usually 7 bundles of the third order between each; stereome very weakly developed as small groups of fibres above and below bundles of the first order forming girders, sometimes also forming minute girders with about every fourth bundle, and as extremely small groups of about 1-5 fibres below almost every bundle, and occasionally also above every second bundle. *Localities*: Walgett-Brewarrina Road (2 collections), Borambil, Murray Downs.

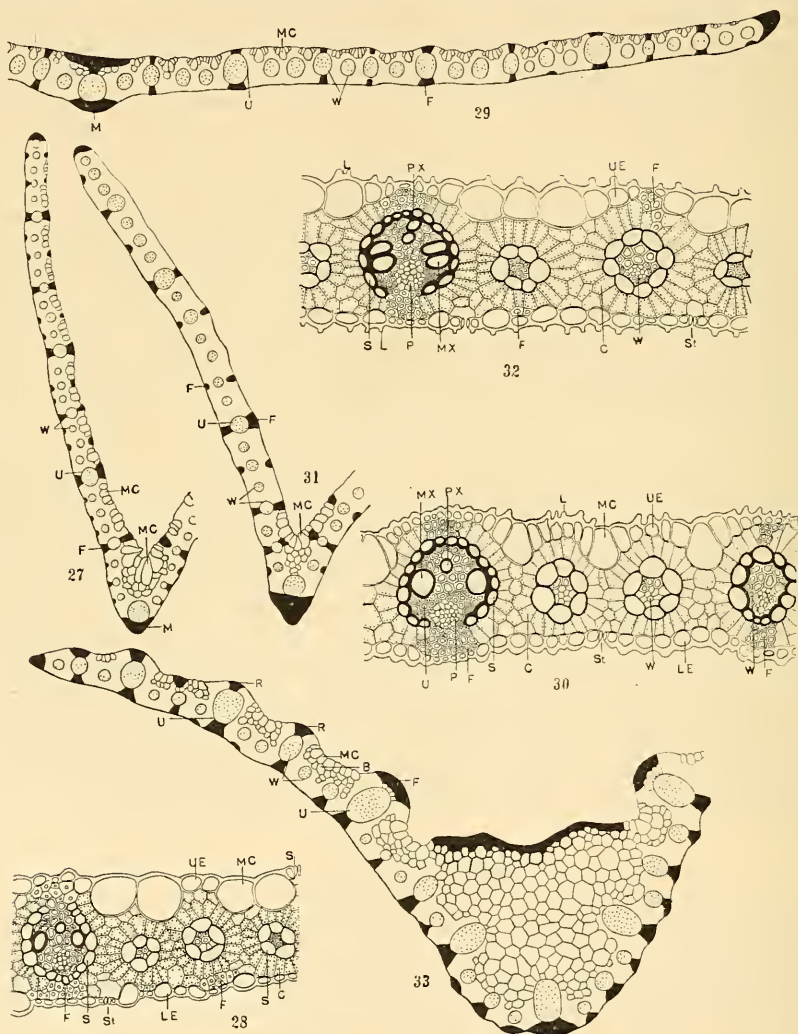
POLLINIA.

POLLINIA FULVA Benth. (Syn. *Erianthus fulvus* Kunth.)

Erect, tufted perennial, rather slender, 60-90 cm. high, leafy at the base forming flag, and the culms also leafy; nodes glabrous or occasionally shortly bearded; sheaths smooth, glabrous or with a few scattered hairs; leaves flat, linear, 5-25 cm. \times 3-4 mm., glabrous or with a few scattered hairs especially near the orifice of the sheath, mostly smooth on the lower surface, smooth to rather rough on the upper surface, inrolling, or sometimes the margins recurving on drying; ligule membraneous, truncate, rather jagged; midrib usually present, but not conspicuous. *Distribution*: Tablelands to the interior. Pasture species.

Anatomical characters: (Text-figs. 29 and 30.) Leaf moderately thin; both

surfaces flat, or sometimes with very shallow grooves over the motor cells; upper epidermis consisting of groups of motor cells, one group occurring between each bundle, separated by a few smaller epidermal cells over the bundles; each motor cell group more or less flattened triangular in outline, as the central cell is distinctly larger than the more flattened lateral cells, the central motor cell occupying rather less than half the thickness of the leaf at that point; all the upper epidermal cells with moderately thick, strongly arched to papillate outer walls, many bearing papillae; lower epidermal cells of medium size, with



Text-figs. 27-33.

27.—*Iseilema membranacea*. $\times 28$. 28.—*Iseilema membranacea*. $\times 150$. 29.—*Pollinia fulva*. $\times 38$. 30.—*Pollinia fulva*. $\times 150$. 31.—*Themeda australis*. $\times 28$. 32.—*Themeda australis*. $\times 150$. 33.—*Themeda avenacea*. $\times 28$.

moderately thick walls, very strongly arched to papillate, often also with papillae on the outer walls; stomates on both surfaces, more numerous on the lower surface; chlorenchyma regular; bundle sheath single, forming a circular layer. About 7-11 bundles of the first order occur, with 3-7 of the third order between each; midrib quite inconspicuous in section to conspicuous; stereome weakly developed as a small group of fibres above and below the larger bundles forming girders, and as an extremely small group above and below, or only below, nearly every second bundle of the third order, often completing very slender girders with these. *Localities*: Coonabarabran, Warialda, Botanic Gardens Sydney.

THEMEDA.

THEMEDA AUSTRALIS Stapf.

(Syn. *Themeda Forskallii* Hack., *Themeda triandra* Forsk., *Anthistiria ciliata* Benth. non Linn., *Anthistiria imberbis* Retz.)

Erect, tufted perennial, 30-200 cm. high, often rather brownish or reddish coloured; nodes glabrous; sheaths somewhat flattened, smooth, glabrous or in some forms with scattered tubercle-based hairs; leaves long, linear, narrow, often tapering to filiform points, 10-30 cm. \times 2-4 mm., almost glabrous, smooth to rough; midrib present; ligule membranous truncate, or ciliate. One form of this species is rather glaucous. *Distribution*: Throughout the State. Pasture and open forest species.

Anatomical characters: (Text-figs. 31 and 32.) Leaf fairly thin; both surfaces flat or almost so; leaf distinctly keeled, folding, the margins recurving on drying; upper epidermis consisting of small cells above the larger bundles, alternating with groups of rather large cells with flat or arched walls, sometimes bearing papillae, and resembling motor cells, over the smaller bundles. These larger cells occupy one-quarter to one-third of the thickness of the leaf. A distinct group of larger, thin-walled motor cells sometimes occurs over the midrib; lower epidermis consisting of small cells whose outer walls are strongly arched, and bear small but prominent, sometimes bifurcate papillae; both surfaces bearing occasional asperities; stomates most numerous on the lower surface, very few on the upper surface; chlorenchyma regular around the bundles, with few cells between; bundle sheath single, strongly sclerized around bundles of the first order, thinner walled around the smaller bundles, forming a circular layer. About 7-9 bundles of the first order occur, with 3-7 bundles of the third order between each; midrib distinct owing to the keeling of the leaf, but usually not large, composed essentially of just the midvein, with a mass of fibre below it projecting on to the lower surface, and sometimes with a few colourless cells above it. In a specimen from Glenbrook, however, a large midrib is present, consisting of a large mass of colourless tissue above the midvein and associated bundles, and the motor cell group immediately above the midrib is absent; stereome very weakly developed as a very small mass above and below the first order bundles forming girders, and as extremely small groups above and below about every second bundle of the third order, often joined to them to form small girders. *Localities*: Warialda, Collarenebri-Walgett Road, Bourke, Megalong, Homebush, Glenbrook.

THEMEDA AVENACEA Hack. (Syn. *Anthistiria avenacea* F.v.M.)

Tall, erect, tufted perennial, 90-200 cm. high, rather glaucous, producing abundant flag; nodes glabrous; bases of the stem usually swollen and the sheaths surrounding them woolly hairy; culm sheaths smooth, glabrous; leaves narrow, becoming filiform, rather glaucous and scabrous, 12-40 cm. \times 1-5 mm., folding

inwards on drying, the margins rarely recurving; midrib rather conspicuous in the wider flat leaves, or the leaf reduced to a midrib region in filiform leaves; ligule membranaceous, jagged or ciliate. *Distribution*: Tableland to interior. Pasture species.

Anatomical characters: (Text-fig. 33.) Leaf moderately thick; lower surface flat; upper surface with low ribs and shallow grooves, sometimes so low as to be merely undulating, the ribs usually over alternate bundles; upper epidermis consisting of small epidermal cells over the ribs, and groups of 3-8 fairly small motor cells in the grooves, sometimes with a few colourless cells below them, especially in the western specimens; motor cells of similar size, occupying about one-quarter to one-third of the thickness of the leaf at the grooves; epidermal cells all bearing prominent papillae, the walls of moderate thickness; lower epidermis of cells with moderately thick outer walls, bearing prominent, sometimes bifurcate papillae; stomates on both surfaces, rather more numerous on the lower surface, those on the upper surface mostly on the sides of the grooves; chlorenchyma in a fairly regular row around the closely spaced bundles, or sometimes with a number of additional cells between the rows, making the arrangement somewhat intermediate in type; bundle sheath single, forming a circular or oval layer. About 7-11 bundles of the first order occur, with 3-7 bundles of the third order between each. About every second or third bundle (i.e. bundles of the first order, and larger third order bundles) occupies a rib, with small bundles of the third order below the grooves; midrib conspicuous, with a mass of colourless tissue above the midvein and associated bundles; stereome developed as moderately small groups above and below every second bundle forming girders with them, and sometimes below and usually connected to the others. *Localities*: Scone, Warialda (2 collections).

In a specimen from Bourke, the leaf is larger and thicker than in the above, with about 2 small bundles of the third order under the grooves (between the larger bundles). Colourless cells below the motor cells well developed; some asperities present on the surface. Filiform leaves may also occur in which the leaf consists mainly of an enlarged midrib region with barely any expanded lateral portions; stereome rather more strongly developed with a group of fibres below and attached to every bundle; a large mass of colourless tissue occurring above the bundles. *Locality*: Rockhampton.

ZOYSIAE.

NEURACHNE.

NEURACHNE MITCHELLIANA Nees.

Erect, tufted perennial, 15-45 cm. high, the base of the stems and basal shoots swollen and covered with woolly hairs; culms covered with woolly hairs which rub off where not protected by the sheaths; stem leafy, no flag produced; nodes ciliate; sheaths and nodes short, about 2-4 cm. long; sheaths and leaves irregularly ciliate with long tubercle-based hairs, especially the margins of the leaves; leaves narrow ovate-lanceolate, or linear, narrowing rather abruptly to a point at the top, 1-5 cm. \times 3-5 mm., smooth, and very slightly scabrous on the margins, to slightly rough but not scabrous on the surface, sometimes slightly glaucous, rather inrolled on drying; midrib not noticeable; ligule ciliate. *Distribution*: Interior. Pasture and open forest species.

Anatomical characters: (Text-figs. 34 and 35.) Leaf fairly thick; upper surface flat or very slightly undulating; lower surface regularly undulating with

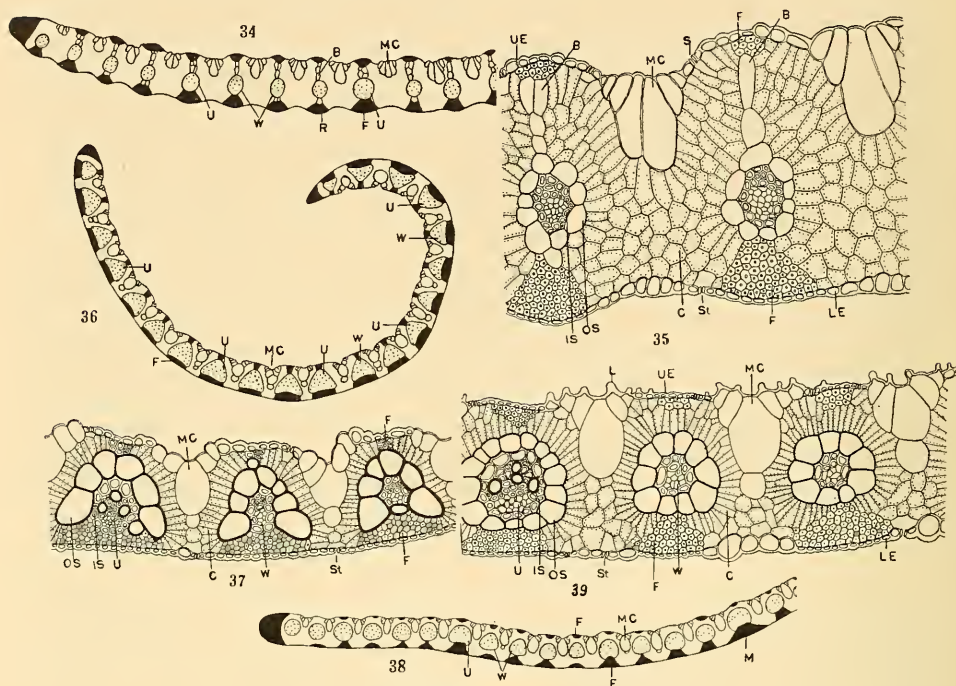
low flat ribs below the bundles; upper epidermis consisting of groups of small cells with moderately thick, flat or arched outer walls, alternating with deep, but narrow groups of 5-6 motor cells, of which the central cell is conspicuously the largest, occupying one-third to one-half the leaf thickness, the lateral ones increasingly smaller towards the side, so that the group is deeply triangular in outline; lower epidermis of small cells with thick, flat or arched outer walls, those between the bundles (under the motor cell groups) usually decidedly larger than the rest, but thick-walled; stomates numerous on both surfaces; chlorenchyma irregularly arranged, about two rows occurring around the bundles, and numerous others between the widely spaced bundles; bundle sheath double, the inner one always strongly sclerized, the outer one thin-walled, and usually consisting of slightly larger cells around the third order bundles than around the first order bundles, forming a circular or oval layer; outer sheath usually connected with the hypodermal fibre groups below the upper epidermis by 1 or 2 rows of colourless, rather elongated cells; midrib indistinguishable except for its position. About 5-7 bundles of the first order occur, with 3-4 bundles of the third order between each; all the bundles rather similar in size, widely spaced; stereome developed as a moderately large mass below each bundle, usually connected to the outer sheath, and as a very small hypodermal group above the bundles, with which it is connected by the colourless cells. Sometimes the colourless cells are absent, and the fibre group is larger, and connected with the bundles forming girders (as in the specimen from Cobar). *Localities*: Collarenebri-Walgett Road, Cobar, Broken Hill, Uriseno-Thurlow Downs.

NEURACHNE ALOPECUROIDES R.Br.

Erect, tufted grass, 15-45 cm. high, leaves chiefly at the base, forming a small amount of flag; the lower portion of the stem rather thick but not conspicuously swollen and corm-like as in *N. Mitchelliana*; a few woolly hairs present at the base but not conspicuously developed; stems slightly angular; nodes shortly ciliate; sheaths open but remaining wrapped around the stem, striate; sheaths and leaves hairy, with rather rigid hairs, slightly rough, or sometimes only ciliate with occasional hairs; leaves narrow, short, 5-8 cm. \times 1-2 mm., often inrolled. *Distribution*: Interior.

Anatomical characters: (Similar to *N. Mitchelliana*, cf. Text-figs. 34 and 35.) Leaf thick; upper surface probably flat; lower surface undulating or almost ribbed with low ridges under the bundles; upper epidermis of small cells with rather thick, flat or arched outer walls, alternating with groups of 5-8, usually 7, motor cells, all rather flattened, the central one much the largest, the lateral ones progressively smaller, so that a deep triangular group is formed, occupying about half the leaf thickness; upper epidermis bearing a few long hairs; lower epidermis of small cells with thick, flat outer walls, but those in the grooves rather larger though still thick-walled; stomates on both surfaces; chlorenchyma irregular; bundle sheath double, the inner strongly sclerized, the outer thin-walled, forming a circular or oval layer; bundles alternately large (of first or second orders) and small (of third order), about 17-19 in all. In all bundles of the first and second orders, the phloem is divided down the centre by a zone of fibres into two groups (this feature is not shown by the third order bundles). Midrib not distinguishable; stereome rather weakly developed as a broad but thin hypodermal mass in the ridges below all the bundles, but only joined to a few of the largest bundles, and as a very small hypodermal mass above the bundles, but widely separated from

them. The colourless tissue which connects the bundles and the upper group of fibres in *N. Mitchelliana* could not be detected in this material, but may be present. *Locality*: Tammin. Dried material only examined.



Text-figs. 34-39.

- 34.—*Neurachne Mitchelliana*. Slightly more than half the transverse section. $\times 28$.
 35.—*Neurachne Mitchelliana*. $\times 150$. 36.—*Perotis rara*. $\times 38$. 37.—*Perotis rara*. $\times 150$.
 38.—*Tragus racemosus*. $\times 28$. 39.—*Tragus racemosus*. $\times 150$.

NEURACHNE MUNROI F.V.M.

Small tufted grass, 15–40 cm. high, the lower part of the stem rather thickened but not conspicuously swollen, woolly hairy at the nodes; culm nodes also ciliate; leaves mainly towards the base; stem slightly angular; sheaths glabrous, open but closely rolled around the stem, smooth or slightly scabrous; leaves very narrow lanceolate (tapering somewhat towards the base), 1–8 cm. \times 1–3 mm., nearly glabrous, or with a few tubercle-based hairs, fairly smooth, or slightly scabrous on the lower surface, inrolled on drying; midrib absent; ligule ciliate. *Distribution*: Interior.

Anatomical characters: Leaf moderately thick; upper surface with low, rounded ribs over every bundle, those over the larger bundles broader, but very slightly higher than those over the small bundles; lower surface also undulating, or with low ribs below each bundle; upper epidermal cells over the ridges with moderately thick, strongly arched to rather papillate outer walls; epidermis in the grooves consisting of groups of 5–8 motor cells, which are increasingly large towards the centre of the group; numerous pointed hairs present on the upper

surface; lower epidermis of thick-walled cells with flat, or only slightly arched outer walls, little more than half as large as the upper epidermal cells, and bearing a few scattered hairs and asperities; stomates on both surfaces, chiefly on the sides of the grooves; chlorenchyma apparently rather irregular, but the bundles much more closely spaced than in *N. Mitchelliana*; bundle sheath apparently of one layer only, forming a circular layer. About 23 bundles occur, of which about every second is either a first or second order bundle, the remainder third order bundles; midrib indistinguishable; stereome moderately developed as a group of fibres below each bundle, occupying the ribs, and above every second bundle, a larger group over every fourth bundle; stereome usually not connected to the bundles. *Localities*: Cobar, Upper Arckaringa Valley (S.A.). Dried material only examined.

PEROTIS.

PEROTIS RARA R.Br.

Small, tufted grass, ascending, 15-30 cm. high, mainly leafy near the base, but not forming much flag; nodes glabrous; sheaths glabrous, smooth; leaves thin, linear to very narrow lanceolate, 1-5 cm. \times 1-4 mm., fairly flat, or inrolled on drying, glabrous, very slightly rough, or a very few hairs may be present; ligule extremely short, truncate. *Distribution*: Western slopes to interior. Pasture species.

Anatomical characters: (Text-figs. 36 and 37.) Leaf very thin; both surfaces flat, or the upper surface with very short narrow grooves over the motor cells; upper epidermis of groups of small papillate cells, with very occasional asperities over the bundles, alternating with deeply triangular groups of 5-7 motor cells between the bundles; central motor cell of each group very conspicuously larger than the more flattened lateral ones, occupying nearly two-thirds the leaf thickness, often with 1 or 2 small colourless cells below it; lower epidermis of small cells with rather thick, arched or slightly papillate outer walls; stomates on both surfaces, more numerous on the lower surface; chlorenchyma regular, consisting of very narrow cells arranged in a narrow row around the sides of the rather closely spaced bundles, interrupted at the base and often at the top of the bundle by the stereome; bundle sheath of two layers, at least around the larger bundles, the inner sheath of small, thick-walled cells, the outer of very large cells which form a distinctly triangular layer around all the bundles, except that they are interrupted at the base of the bundles by the stereome; the triangular outline formed is about as wide as high; the conducting elements forming only very small groups even in the larger bundles. About 21 bundles occur, of which about 7 are small first order bundles; midrib quite undistinguished; stereome fairly well developed for such a thin leaf, forming a wide but rather thin mass of small fibres below each bundle, which extends laterally as far as do the outer bundle sheath cells, and is usually connected with the inner sheath, and a small mass above the bundles, so that a girder is formed with each bundle which is broad at the lower surface, very narrow at the upper surface. *Localities*: Warialda, Pilliga.

TRAGUS.

TRAGUS RACEMOSUS All. (Syn. *Lappago racemosus* Willd.)

Small, tufted annual, erect or ascending, 10-45 cm. high, leafy mainly at the base; nodes glabrous; stems angular; sheaths sometimes rather flattened, glabrous except for a few cilia on the margins, smooth; leaves short, narrow-

lanceolate to linear, 1-5 cm. \times 2-6 mm., the margins ciliate with long, tubercle-based hairs, otherwise mostly glabrous, the surface fairly smooth, rolling on drying; midrib usually absent, occasionally showing very faintly; ligule ciliate. *Distribution*: All over the State, chiefly west of the Divide. Pasture species.

Anatomical characters: (Text-figs. 38, 39.) Leaf moderately thin; both surfaces flat; upper epidermis consisting of very small cells with arched or papillate walls over the bundles, alternating with groups of usually 5 motor cells, of which the central cell is rather narrow but deep, and very conspicuously larger than the lateral somewhat flattened ones, and occupies half or more of the leaf thickness; outer wall of the motor cells also bearing papillae; lower epidermis of rather small cells with fairly thick, flat or very slightly arched outer walls; stomates on both surfaces, very small; chlorenchyma regular, consisting of unusually narrow cells; bundle sheath double around the larger bundles, the inner consisting of small sclerized cells, the outer of broad, but rather short cells with fairly thin walls and very dense contents; inner sheath absent from the smaller bundles; outer sheath forming a layer which is sometimes slightly flattened below the bundle, giving the bundle a very slightly triangular outline, or at other times almost completely circular. About 7-8 bundles of the first order occur, with 2-4 bundles of the third order between each; midrib quite undistinguished; stereome developed as a rather broad but thin group of small fibres below each bundle, often connected to it, and as very small hypodermal groups above the bundle, sometimes connected to the outer bundle sheaths of the first order bundles, rarely to the third order bundles. *Localities*: Warialda (2 collections), Bourke, Homebush.

ZOYSIA.

ZOYSIA BROWNII* C. Muell. (Material identified at Kew, 1931.)

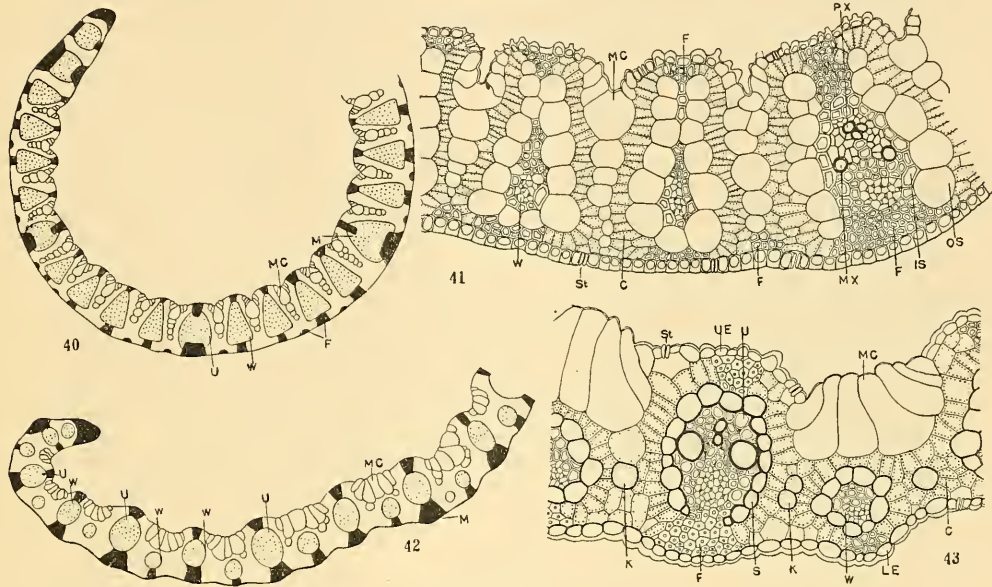
(Syn. *Zoysia pungens* Benth., *Fl. Aust.*, non Willd.)

Perennial, creeping by rhizomes, ascending 7-30 cm., rather like 'couch grass' in habit; leaves all on the culms, crowded, the sheaths short; internodes sometimes, but not always, unequal in length, alternately long and short, so that the leaves approximate in pairs; nodes glabrous, often enclosed by the sheaths; leaves and sheaths glabrous, smooth; leaves linear, 1-10 cm. \times 1-3 mm., narrow, pointed, inrolled on drying; midrib not or scarcely distinguishable; ligule consisting of a few cilia, sometimes almost absent. *Distribution*: Coast, on sand dunes and salt swamps.

Anatomical characters: (Text-figs. 40 and 41.) Leaf moderately thin; both surfaces flat or almost so, sometimes slightly undulating; upper epidermis consisting of small cells with rather thick, arched or papillate outer walls, and bearing numerous, small, often bifurcate papillae, over the bundles, alternating with groups of 5-7 motor cells between the bundles; lateral motor cells of each group flattened, the central one very conspicuously larger, and more rounded, occupying nearly one-third of the leaf thickness, but with a row of colourless, or almost colourless cells below it, which extend three-quarters or the whole way to the lower epidermis; outer walls of the motor cells fairly thin and papillose; lower epidermis of small cells with very thick, flat or very slightly arched outer

* Since this paper went to press, a contribution by C. E. Hubbard in *Icones Plantarum* (Vol. 3, No. 3, Tabular 3264, Aug., 1935) has come to hand in which he shows that the name *Zoysia macrantha* (Tribe Zoisieae) should supersede *Zoysia* (*Zoysia*) *pungens* R.Br. and *Z. Brownii* C. Muell.

walls, forming a compact layer; stomates on both surfaces, fairly small; chlorenchyma regular, consisting of small, narrow cells forming a very narrow row around the bundles, usually interrupted above and below the bundles by the stereome; bundle sheath double; inner sheath of small thick-walled cells, only shown by the larger bundles; outer sheath of large, fairly clear cells, forming a layer which extends upwards towards the upper surface, and is flattened at the lower surface, so that the bundle has a strongly triangular outline, the triangle



Text-figs. 40-43.

40.—*Zoysia Brownii*. $\times 60$. 41.—*Zoysia Brownii*. $\times 210$. 42.—*Arundinella nepalensis*. $\times 28$. 43.—*Arundinella nepalensis*. K, thick-walled cells resembling isolated bundle sheath cells. $\times 150$.

much taller than wide, with its apex towards the upper surface; midrib undistinguished. About 7 bundles of the first order occur, with 3-5, usually 4, bundles of the third order between each; stereome weakly developed as rather small masses above and below the first order bundles forming girders, and as extremely small groups above and below the third order bundles and usually connected with them. A very small hypodermal group of about 3-5 fibres may also occur on the lower side, between the bundles (below the motor cell groups). The first order bundle nearest the leaf margins has a much larger group of fibres above and below it forming a very strong girder, than any other bundle. *Localities*: Harbord, Homebush Bay.

TRISTEGINEAE.

ARUNDINELLA.

ARUNDINELLA NEPALENSIS Trin.

Tall, cane-like perennial, 90-240 cm. high, creeping by means of short rhizomes with slightly swollen nodes, and sending up stiff, erect culms, producing little leaf and no flag; nodes glabrous; sheaths glabrous, mostly smooth, or some-

times rough downwards, rather striate; leaves linear, 5-25 cm. \times 3-8 mm., slightly glaucous green, the margins and upper surface scabrous, the lower surface sometimes smooth, inrolling on drying; midrib inconspicuous, or very slightly shown towards the base; ligule minute, truncate. *Distribution*: Coast to interior, chiefly in the north.

Anatomical characters: (Text-figs. 42 and 43.) Leaf of moderate thickness; both surfaces somewhat undulating, scarcely ribbed; upper epidermis consisting of alternating groups of small, arched to papillate cells above the bundles, and groups of about 3-7 large motor cells, which are progressively larger towards the centre of each group, and occupy nearly half the thickness of the leaf at the point where they occur; all cells of the upper epidermis moderately thin-walled. A few colourless cells may occur below the motor cell groups; lower epidermal cells with rather thick, flat or slightly arched outer walls; stomates on both surfaces, rather more numerous on the lower surface; chlorenchyma arranged fairly regularly in a row around the bundles, with a few additional cells between the bundles, sometimes somewhat intermediate in type between the regular and irregular arrangements; bundle sheath single, the cells only a trifle more sclerized around the larger bundles, forming a circular layer; bundles of three types, first order, large bundles of the third order (with no vessels, but a considerable amount of lignified tissue and a distinct phloem group), and smaller third order bundles with less lignified tissue. The larger bundles are alternately first and large third order bundles, with 1 or 2 small third order bundles between each; midrib almost or completely indistinguishable; stereome developed as moderate-sized masses above and below all the larger bundles, usually forming girders. Between almost every bundle, one or two rounded, rather thick-walled cells resembling isolated bundle sheath cells occur (K, Text-fig. 43). *Localities*: Warialda, Barraba, Gulgong.

SUMMARY.

The leaf anatomy and vegetative characters of the indigenous grasses of New South Wales belonging to the tribes Andropogoneae, Zoysieae and Tristegineae are described and illustrated.

In conclusion, I desire to thank Professor T. G. B. Osborn, of the Department of Botany, Sydney University, who first suggested this work to me, for his helpful interest during the course of the investigation.

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